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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
B60C 11/03, 11/00, 11/13

A1

(11) International Publication Number: WO 99/17943

(43) International Publication Date: 15 April 1999 (15.04.99)

(21) International Application Number: PCT/GB98/02972

(22) International Filing Date: 2 October 1998 (02.10.98)

(30) Priority Data:

9721059.5	4 October 1997 (04.10.97)	GB
9810629.7	19 May 1998 (19.05.98)	GB

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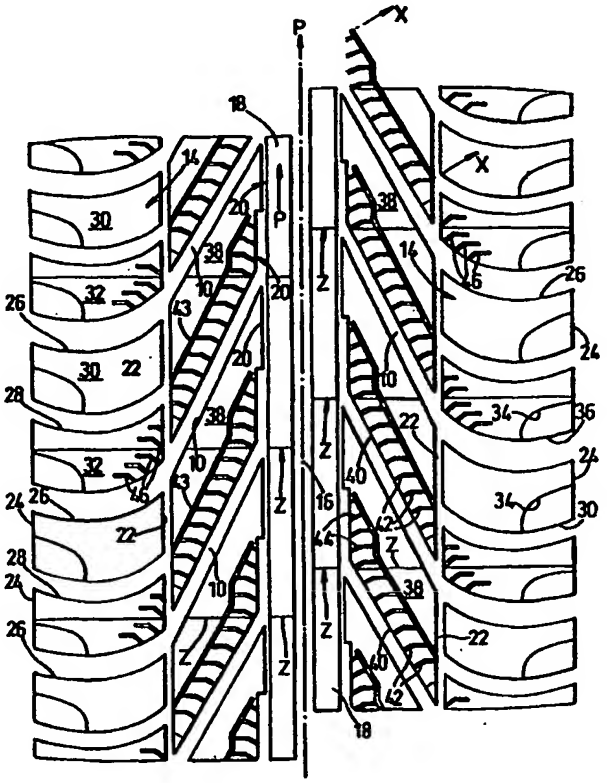
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: TYRE

(57) Abstract

A tyre for a vehicle wheel, the tyre having a tread portion intended to engage the ground and being so constructed and arranged that when a wheel carrying the tyre is rotated in a first direction it provides a performance suitable for summer conditions and that when a wheel carrying the tyre is rotated in a second direction opposite the first direction it provides a performance suitable for winter conditions.



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TYRE

This invention is concerned with improvements in or relating to tyres for a vehicle wheel.

Some countries require tyres for winter use to have a particular performance characteristic, different from those which are required for summer use. In such countries, it is common practice to have two sets of tyres and/or wheels for a vehicle and to exchange the sets of tyres and/or wheels at an appropriate date. So-called "all season tyres" have also been proposed, such tyres being designed to perform satisfactorily all year round but such tyres, as currently available, provide a compromise which does not perform outstandingly in either summer or winter.

In addition, it has recently been proposed to provide tyres which are directional insofar as they are designed to be used when rotating in a particular direction so that the tread portion, where it contacts the ground, provides optimum characteristics when rotated in that direction.

The term "tyre" is used herein in a general sense and includes tyres suitable for any sort of vehicle, for example cars, trucks, lorries and construction vehicles and for use on a variety of surfaces including roads and for off-road vehicles. Furthermore, the term "tyre" is intended to include inflatable tyres and resilient non-inflatable tyres, such tyres being made from rubber compounds, or compounds of other suitable elastomeric materials.

One of the various objects of the present invention is to provide an improved tyre.

To this end, the inventors propose to provide a quaquaversal tyre which has characteristics related to the direction of rotation of the wheel on which the tyre is mounted so that when rotated in one direction the tyre provides summer characteristics and when rotated in the opposite direction the tyre provides winter characteristics.

In one aspect the invention may be considered to provide a tyre for a vehicle wheel, the tyre having a tread portion intended to engage the ground and being so constructed and arranged that when a wheel carrying the tyre is rotated in a first direction it provides a performance suitable for summer conditions and that when a wheel carrying the tyre is rotated in a second direction opposite the first direction it provides a performance suitable for winter conditions.

In another aspect the invention may be considered to provide a tyre for a vehicle wheel wherein the tread portion comprises:

(i) a plurality of first inclined grooves inclined at an acute angle to a circumferential line around the tread portion considered from the leading end of the groove to the trailing end of the groove when the tyre is rotated in a first direction and extending from a central region of the tyre towards a shoulder region of the tyre; and

(ii) a continuous relatively rigid part or parts of the tread portion, or a first continuous groove or grooves extending circumferentially around the tyre at the central region of the tread portion.

Preferably a tyre in accordance with the invention also comprises two second continuous grooves extending circumferentially around the tread portion one at either side of the central region, the second

continuous grooves separating shoulder regions of the tread portion from the remainder of the tread portion. Preferably the second continuous grooves are spaced substantially equidistantly from the central region and the outer edge of the adjacent shoulder region.

In a tyre in accordance with the invention which comprises a continuous relatively rigid part
or parts of the tread portion extending circumferentially around the tyre at the central region of the tread portion, the rigid part may comprise a single rigid part or a plurality of rigid parts separated one from the next by relatively narrow continuous circumferential grooves and the outer rigid parts being likewise separated from the remainder of the tread portion by relatively narrow circumferential grooves. Suitably only two relatively rigid parts are utilised.

In a tyre in accordance with the invention which comprises a first continuous groove or grooves extending circumferentially around the tyre at the central region of the tread portion this may be a single groove or a plurality of grooves each separated from the next by a relatively narrow circumferential land.

In a tyre in accordance with the invention which comprises a first continuous groove or grooves, circumferentially extending lands define the groove or grooves. These lands are desirably separated from the remainder of the tread portion by relatively narrow continuous grooves. The first continuous groove or grooves are at least as wide as, and preferably wider than, the lands bounding the first continuous groove or grooves.

Conveniently, in a tyre in accordance with the invention the first inclined grooves become progressively wider from the end of the inclined groove at the central region towards their outer ends closer to the outer edge of the tread portion.

In one embodiment, the first inclined grooves of a tyre in accordance with the invention are arranged in pairs, the ends of the grooves of each pair at the central region suitably lying at a region extending transversely of the tread portion which is generally parallel with the axis of rotation of the tyre.

Preferably, a tyre in accordance with the invention comprises first shoulder grooves which meet and provide continuations of the first inclined grooves and which extend across the shoulder region to the outer edge portion of the shoulder region. Conveniently, the first shoulder grooves extend across the shoulder regions in a direction generally parallel with the axis of rotation of the tyre. Suitably, the tyre also comprises second shoulder grooves positioned between and parallel with the first shoulder grooves and likewise extending across the shoulder region to the outer edge portion of the shoulder region. There may be only one or a plurality of second shoulder grooves between adjacent ones of the first shoulder grooves. Preferably where the tyre comprises second continuous grooves separating the shoulder regions from the remainder of the tread portion the inner end portion, of the second shoulder grooves open from the adjacent second continuous groove.

The first inclined grooves of a tyre in accordance with the invention may have any suitable configuration, for example they may be straight or may be slightly curved so long as they extend generally at an acute angle

as hereinbefore set out. Adjacent inclined grooves at the same side of the central region are preferably parallel to one another (when the tread pattern is projected onto a flat surface). Conveniently, if the first inclined grooves are not straight, they may be curved such that the acute angle at which a tangent to the outer end of the groove meets the central region is greater than the angle at which a tangent to the groove adjacent the central region meets the central region.

Although the shoulder grooves extend generally across the shoulder region of a tyre in accordance with the invention, the shoulder grooves are conveniently curved so that they are concave facing in the first direction; that is the curvature is in the same sense as the preferred curvature of the first inclined grooves in those cases where the first inclined grooves are not straight.

The shoulder grooves are defined by lands of the shoulder region. Preferably, the lands each include a recess in that land edge portion which defines the leading edge of a shoulder groove considered when the tyre is rotated in the first direction, the recess being at an outer edge portion of the tread region.

In the use of a tyre in accordance with the invention the first shoulder grooves facilitate shedding of water where the tyre is running on a wet surface and the first and second shoulder grooves also provide better traction in winter conditions.

The first inclined grooves of a tyre in accordance with the invention are defined by lands of the tread portion at either side of each first inclined groove. Preferably, in a tyre in accordance with the invention the trailing

land edge portion defining a leading edge portion of a first inclined groove considered when the tyre is rotated in a first direction has a series of cuts. Thus, the land edge portion defining the leading edge portion of the first inclined groove is provided with a plurality of formations which, when the tyre is rotated in the first direction tend to be urged towards one another at the region of the tread portion which contacts the ground to present a relatively smooth ground-engaging surface providing a less aggressive grip on the ground surface than when the tyre is rotated in the second direction, in which the formations tend to be urged apart (at the ground-engaging region) to present a rougher ground-engaging surface providing improved traction compared with the traction when the tyre is rotated in the first direction. Preferably, the cuts are generally parallel to one another and preferably the cuts extend in a direction generally parallel to the axis of rotation of the tyre, although if desired they may extend in other directions, they should preferably extend to some extent transversely of the tread portion.

Although reference is made to cuts, this is a term of reference which does not imply that the cuts are formed by a cutting action: the cuts are commonly moulded (as are grooves and channels in the tread portion) during a tread moulding operation, but are relatively narrow and have the general appearance of cuts.

Conveniently, cuts parallel with the cuts in the land edge portion defining an inclined groove may also be formed in a land edge portion defining a second continuous groove.

In a tyre in accordance with the invention comprising shoulder grooves, cuts are also provided in a trailing land edge portion which

defines the leading edge of a shoulder groove considered when the tyre is rotated in the first direction. Preferably, these cuts are also generally parallel to one another and are preferably parallel with the axis of rotation of the tyre or at least extend transversely to the tread portion of the tyre to some extent. Conveniently, cuts parallel with the cuts in the land edge portion defining a shoulder groove are also formed in the land edge portion of the shoulder region defining a second continuous groove.

Preferably the cuts have two parts which make an obtuse angle to one another, a first part generally parallel with the axis of rotation of the tyre and a second part opening into a first inclined groove or into a shoulder groove which is generally at right angles to the direction in which the inclined groove or shoulder groove extends. Where the cuts have two parts, each cut is generally parallel with the other cuts throughout the two parts.

In a preferred tyre in accordance with the invention the cuts formed in the land which defines a first inclined groove are connected by a narrow channel generally parallel with the first inclined groove into which the cuts open, the channel interconnecting ends of the cuts remote from the inclined groove. The channel may also interconnect the ends of the cuts in the land which open into a second continuous groove. The channel is believed to facilitate provision of appropriate flexibility of each of the land portions bounded by the cuts, channel and either the first inclined groove or second continuous groove as appropriate.

In a preferred tyre in accordance with the invention the cross-sectional shapes of the inclined grooves and shoulder grooves are designed so that the tread portion affords increased traction where it engages the

ground when the tyre is rotated in the second direction than when the tyre is rotated in the first direction.

The inclined grooves and shoulder grooves are defined by lands at either side of each groove. Preferably, the tread surface of the land where it meets the leading edge of a groove considered when the tyre is rotated in the first direction subtends an angle with the wall of the groove at its leading edge which is smaller than the angle subtended by the tread surface of a land defining the trailing edge of the groove (considered when the tyre is rotated in the first direction) and the wall of its groove at its trailing edge. Preferably, the angle subtended at said leading edge of the groove is between 90° and 94°, conveniently about 92° and the angle subtended at said trailing edge is suitably between 96° and 100°, conveniently about 98°.

Preferably in a tyre in accordance with the invention, considered between the centres of adjacent inclined or shoulder grooves of the tread at either side of a single land, a first half of the distance between the centres consists of a leading portion of a first groove and a trailing portion of said single land and the other half of the distance between the centres consists of a leading portion of the land and a trailing portion of a second groove at the opposite side of the land to the first mentioned groove. Preferably, the ratio of the circumferential width of said trailing portion of the land to the leading portion of the first groove is greater than the ratio of the width of said leading portion of the land to the trailing portion of the second groove. Conveniently, the ratio of the circumferential width of said trailing portion of the land to said leading portion of the first groove is about 70/30 and the ratio of the width of said leading portion of the land to the trailing portion of the second groove is about 50/50. Suitably, the

ratio of the width of the land to the width of one of the inclined grooves at either side of it is about 60/40. Where the inclined grooves become wider towards their outer end these ratios may change.

The hardness of the tyre tread compound will also have an affect on the performance characteristics of a tyre. Conveniently, the tread portion of a tyre in accordance with the invention has a hardness at minus 5°C ambient air temperature in the range 58-66 on the Shore A scale, preferably about 64-65. It may also be beneficial to replace some of the carbon black reinforcement of the tread compound with a percentage of a silica reinforcement.

When wishing to convert from summer performance to winter performance and vice versa, in a tyre in accordance with the invention, the wheels of a vehicle can be exchanged so that the wheels from the off-side of the vehicle will be transferred to the near-side of the vehicle and those from the near-side to the off-side thus ensuring that all of the tyres are rotating in the opposite direction once they have been swapped in this way, thereby affecting a change between summer and winter characteristics without requiring two different sets of tyres or wheels.

In the accompanying drawings:-

Figure 1 is a perspective view of a tyre on a wheel showing the tread pattern;

Figure 2 is another view showing the tread portion of a tyre;

Figure 3 is a diagrammatic view showing a groove on a part of the tread portion of a tyre;

Figure 4 is a diagrammatic plan view showing part of a tread portion of a first tyre embodying the invention;

Figure 5 is a perspective view of a second tyre embodying the invention having a tread portion generally similar to Figure 3, except as hereinafter described;

Figure 6 is a plan view of a part of the tread portion of a third tyre embodying the invention;

Figure 7 is a perspective view of a fourth tyre embodying the invention;

Figure 8 is a diagrammatic view in section of part of the tread portion of a tyre embodying the invention across two of the first inclined grooves;

Figure 9 is a diagrammatic plan view showing part of a tread portion of a fifth tyre embodying the invention; and

Figure 10 is a view in section on the line X-X of Figure 9.

To ensure that satisfactory performance is gained tyres in accordance with the invention should have certain characteristics.

These characteristics are described generally hereinafter with reference to Figures 1 to 3 of the accompanying drawings which illustrate certain characteristics of tyres suitable for use in the invention.

In order to perform satisfactorily a tyre in accordance with the invention must have a tread pattern on the tread portion which, when the tyre is rotated in a first direction, provides a less aggressive grip on the road surface than when rotated in the second direction. In the accompanying drawings the first direction is indicated by the arrow P and the axis about which the tyre is intended to rotate is indicated by the line A-A.

A tyre in accordance with the invention has a plurality of grooves or cuts 2. Some of these grooves 2 are arranged in pairs each inclined at an acute angle X (see Figure 3) to a circumferential line around a central region of the tread portion of the tyre considered from the leading end of the groove 2, at the central region, to the trailing end adjacent a shoulder region of the tyre when the tyre is rotated in the first direction. These grooves are preferably relatively wide.

It will be seen when viewing figure 3 that when the tyre is rotated opposite the first direction in a second direction (that is in a direction opposite the arrow P in Figure 3) the pairs of grooves 2 will be presented to the ground in a different orientation with the ends of the grooves adjacent the shoulder region 4 of the tyre leading. It is believed that a tyre rotating in the first direction presents a less aggressive contact with the road surface and is more appropriate for summer use than when rotated in the second direction when the orientation of the grooves causes the tyre to present a much more aggressive contact with the ground thereby providing improved traction in winter conditions where the ground may be icy or covered with snow.

The pairs of grooves 2 extend from a central region of the tread portion towards the shoulder region 4 of the tyre at an acute angle to the circumferential line when considered from the central region 4 towards the shoulder of the tyre.

Preferably the tyre has relatively heavy block shoulder regions 4 and has good inherent directional stability facilitated either by a substantially continuous relatively rigid region of the tread portion 6 extending somewhat, like a band, circumferentially around the tyre as

shown in Figure 1 of the drawings or by a continuous groove running circumferentially around the tyre. A combination of circumferential grooves or relatively rigid regions may be provided. A single groove may be provided around the centre of the tread portion or a plurality of parallel circumferential grooves may be provided at spaced intervals. A single rigid region may be provided at a central region of the tread portion or a plurality of spaced circumferential rigid regions may be provided to provide directional stability. The heavy block shoulder regions also contribute to the directional stability of the tyre.

The cuts and grooves in the tyre may be of various depths provided that some of the grooves or cuts are designed to provide good water expulsion from between the tyre tread portion and the ground where it is engaged by the tread portion, irrespective of the direction of rotation of the tyre.

The tread patterns around the tread portion especially the shoulder regions of the tyre desirably may be of varying, randomly distributed, pitch lengths (see for example the block shoulders 4a, 4b and 4c and adjacent grooves and tread surface in Figure 1).

The tread portion additionally comprises a plurality of formations (commonly referred to as sipes), which when the tyre is rotated in the first direction P, tend to be urged towards one another at the region of the tread contacting the ground thereby to present a relatively smooth ground-engaging surface. The sipes are arranged such that when the tyre is rotated in the second direction (opposite to the direction P) they tend to be urged apart at the ground-contacting region to present a more open pattern than when rotating in the first direction. Thus, it is expected that the tyre

when rotated in the second direction will give a more aggressive attack and greater traction on winter ground surfaces which are likely to be icy or covered in snow than when rotated in the first direction where the aggressiveness needed for traction is likely to be somewhat less. The formations or sipes may be inclined randomly at varying angles to facilitate the desired movement apart or together as discussed above or they may be generally parallel to one another.

The sipes may be formed by making relatively narrow cuts or indents into lands of the tread portion between the major grooves or cuts 2 and, if necessary, in the block shoulder regions 4.

In general the tread pattern will preferably be symmetrical about the circumferential centre line of the tyre.

The tread portion of a tyre in accordance with the invention is suitably made from a compound, for example a rubber compound or a compound of suitable elastomeric material, which provides satisfactory performance over a wide range of temperature conditions ranging from ambient temperatures at or below freezing point up to temperatures of 30°C or more and which will also provide satisfactory performance in snowy conditions.

Suitably, the tread portion is made from a compound which, coupled together with the tread pattern design, initiates little resistance to its direction of travel when the tyre is rotated in the first direction, thus generating less heat which is wholly appropriate to relatively high temperature summer conditions and which, when rotated in the second direction, initiates a greater resistance to its direction of travel by inducing

more tread pattern movement, which in turn accelerates heat build up: thus the tyre reaches a working temperature sooner, which is wholly appropriate to relatively low temperature winter conditions.

A preferred tyre tread compound for use in a tyre in accordance with the invention conveniently has a hardness at minus 5°C air temperature in the range 58-66 considered on the Shore A scale, preferably a hardness of about 64-65. Suitably, the tread compound may have some of the carbon black reinforcement material replaced by a percentage of a silica reinforcement.

In figures 4-10 showing the first, second, third, fourth and fifth illustrative tyres, like numbers indicate like parts and the tyres are generally similar to one another except as described herein.

A first tyre embodying the invention has a tread portion as shown in Figure 4. This has a plurality of first inclined grooves 10 inclined at an acute angle to a circumferential line extending around the tread portion considered from the leading end of the groove to the trailing end of the groove 10 when the tyre is rotated in a first direction and extending from a central region of the tyre 12 towards a shoulder region 14. The tyre embodying the invention shown in Figure 4 further comprises a first continuous groove 16 extending circumferentially around the central region 12 of the tread portion. The central region also comprises two continuous relatively rigid parts 18, defining the groove 16, which likewise extend circumferentially around the central region 12 of the tread portion. The continuous groove 16 is approximately the same width as the two rigid parts 18. The rigid parts 18 are separated from the remainder of

the tread portion by relatively narrow grooves 20. The grooves 20 have alternating narrow and wider portions (see Figure 4).

The illustrative tyre shown in figure 4 further comprises two second continuous grooves 22 also extending circumferentially around the tread portion, one at either side of the central region, the second continuous grooves 22 separating the shoulder regions 14 from the remainder of the tread portion. The second continuous grooves 22 are spaced approximately equidistantly from the central region 12 of the first illustrative tyre and the outer edge 24 of the adjacent shoulder region.

The first inclined grooves 10 of the first illustrative tyre are arranged in pairs as can be seen from Figure 4, with the ends of the grooves 10 of each pair at the central region lying at a region extending transversely of the tyre parallel with the axis of rotation of the tyre.

The first illustrative tyre shown in Figure 4 further comprises first shoulder grooves 26 which meet and provide continuations of the first inclined grooves 10 and which extend across the shoulder region 14 to the outer edge portion 24 of the shoulder region 14. The first shoulder grooves 26 extend in a direction generally parallel with the axis of rotation of the tyre and are concave facing in the first direction indicated by the arrow P.

The first illustrative tyre comprises second shoulder grooves 28 positioned between and parallel with the first shoulder grooves 26 and likewise extending across the shoulder region 14 to the outer edge portion of the shoulder region. The second shoulder grooves 28 open from the adjacent second continuous groove 22. As can be seen viewing figure 4

the lands 30, 32 defining the shoulder grooves are of varying, randomly distributed pitch lengths and the grooves 26 are of varying widths. The lands, 30, 32 each have a recess 34 in the trailing land edge portion 36 which defines the leading edge of one of the shoulder grooves 26, 28 considered when the tyre is rotated in the first direction indicated by the arrow P, the recesses 34 being at an outer edge portion of the tread region.

The first inclined grooves 10 are defined by lands 38 of the tread portion at either side of each first inclined groove 10 and the trailing land edge portion 40 defining a leading edge portion of a first inclined groove 10, considered when the tyre is rotated in the first direction indicated by the arrow P, has a series of cuts 42. The cuts 42 are generally parallel to one another and to the axis of rotation of the tyre. The edges of the lands 38 defining the narrow circumferential grooves 20 are also provided with cuts 44 extending partially across the land 38 parallel with the cuts 42, the cuts 44 being present only at a trailing region of the land 38 defining the wider part of the groove 20 considered when the tyre is rotating in the first direction indicated by the arrow P.

Cuts 46 are also provided in a trailing edge portion of the lands 32 of the shoulder region which defines the leading edge of one of the first shoulder grooves 26 considered when the tyre is rotated in the first direction P. The cuts 46 are also generally parallel with the axis of rotation of the tyre (and therefore with the cuts 42, 44). The cuts 46 are also formed in a trailing region of the lands 32 which defines the second continuous grooves 22.

The second illustrative tyre is generally similar to the first illustrative tyre except as shown in Figure 5. The central region 12 of the second illustrative tyre comprises two relatively rigid parts 19 separated by a narrow central groove 21 (instead of the wider central groove 16 of the first illustrative tyre). There are also other variations for example the lands 30, 32 of the shoulder regions do not have recesses corresponding with the recesses 34 of the first illustrative tyre and additional channels 43 which extend across the ends of the cuts 44, 42 generally parallel with the grooves 10 are provided in the lands 38.

The third illustrative tyre is shown in figure 6 and is generally similar to the first illustrative tyre except as shown in the drawing. For example, the central region 12 of the third illustrative tyre has a single first continuous groove at the central region defined by two relatively narrow rigid parts 17 which are separated from the remainder of the tread portion by the relatively narrow grooves 20. Furthermore, in the shoulder regions, the second shoulder grooves 28 do not open from the second continuous grooves 22 but instead are separated from them by a bridge joining the two lands 30, 32 defining each second groove 28. In addition, the cuts 42, 46 whilst being parallel with one another are not parallel with the axis of rotation of the tyre although they extend to some extent transversely of the tread portion. There are also no cuts corresponding with the cuts 44 of the first illustrative tyre on the edge portion of the lands 38 defining the groove 20. Nor do any of the cuts 46 open from the portion of the lands 32 defining the second continuous groove 22. The cuts 42 of the third illustrative tyre include a number of cuts 45 which are somewhat longer than the remainder of the cuts 42.

The first inclined grooves 10 of the third illustrative tyre differ from those of the first and second illustrative tyre because they become progressively wider from their end 11 adjacent the central region 12 of the tread portion towards their outer ends 13. This widening of the grooves it will also be noted that the ends 11 of each pair of grooves are not in precise alignment transversely of the tread pattern although the first grooves are clearly arranged in pairs.

The fourth illustrative tyre shown in Figure 7 is generally similar in many respects to the third illustrative tyre. However, the central region 12 has a single rigid part 15 extending circumferentially therearound separated from the remainder of the tread portion by narrow grooves 20, instead of the central groove 16. Furthermore, the second groove separating the shoulder regions 14 from the remainder of the tread portion, while being continuous, is of a zig/zag configuration. A further distinction from the third illustrative tyre is that there are no second shoulder grooves 28, only first shoulder grooves 26.

The fifth illustrative tyre shown in Figures 9 and 10 is generally similar except as shown in Figures 9 and 10 to the first illustrative tyre (and has some aspects of the second illustrative tyre).

In the fifth illustrative tyre the first inclined grooves 10 disposed to a first side of the central region are staggered in relation to the first inclined grooves disposed to the other, second, side of the central region but the pitch of the repeating tread patterns at either side of the central region is indicated by the lines Z on Figure 9 (which do not represent an actual structural feature). The degree of stagger can be seen from Figure

9. The stagger is intended to reduce noise generated by the tread on the road, in use.

The cuts 42, 44, 46 in the land portions 38, 32 have two parts which make an obtuse angle with one another, as can be seen from Figure 9. A first part, remote from the groove 10, 26 into which the cut opens, is generally parallel with the axis A of rotation of the tyre. A second part opens into an appropriate groove 10 (or 20), 26 (or 22); where the second part opens into a first inclined groove 10 or a shoulder groove 26, it is generally at right angles to the direction in which the groove extends. As can be seen the cuts 42, 44, 46 are generally parallel with one another.

A channel 43 interconnects the ends of the first part of the cuts 42, 44 remote from the appropriate one of the grooves 10, 20. As can be seen viewing Figure 9, the channel 43 is generally parallel with the grooves 10 except for a short circumferentially extending portion which allows larger sipes adjacent the groove 20 than would otherwise be the case.

The channels 43 facilitate provision of appropriate flexibility of each of the sipes. Figure 10 indicates the profile of the channel which, likewise is chosen to provide adequate support but sufficient flexibility in the region of the sipes.

In the first to fifth illustrative tyres described herein, the inclined grooves 10 and the shoulder grooves 26, 28 are defined by lands at either side of each groove as discussed above. In Figure 8 a pair of adjacent inclined grooves 10 are shown diagrammatically in section partially through the tread portion of the first illustrative tyre. However, the inclined grooves of the other illustrative tyres are of generally similar

configuration. The shoulder grooves of the illustrative tyres may also be of similar configuration to that of the inclined grooves 10 shown in Figure 8. The tread surface 39 of a first land 38 where it meets the leading edge 50 of a groove 10 considered when the tyre is rotated in the first direction P subtends an angle θ with the wall 52 of the groove 10 at its leading edge 50 which is smaller than the angle γ subtended by the tread surface 39 of a second land 38 defining the trailing edge 54 of the groove 10 and the wall 56 of the groove at its trailing edge 54. In the illustrative tyres the angle θ is approximately 92° and the γ angle is approximately 98°.

The centres C of adjacent grooves 10 are indicated in Figure 8 and the distance between the centres of the grooves C is indicated by distance D. A dash-line E indicates half of the distance (D/2) between the centres C.

A first half of the distance between the centres C consists of a leading portion 58 of a first groove 10 and a trailing portion 60 of the land 39 and the other half of the distance between the centres C consists of a leading portion 62 of the land 39 and a trailing portion 64 of a second one of the grooves 10 adjacent the first mentioned groove 10. As can be seen from Figure 8 the ratio of the circumferential width of said trailing portion 60 of the land 39 to said leading portion 58 of the first groove is greater than the ratio of the width of said leading portion 62 of the land 39 to the trailing portion 64 of the second groove. Conveniently, the ratio of the width of the trailing portion 60 of the land to the leading portion 58 of the first groove is about 70/30 and the ratio of the circumferential width of the leading portion 62 of the land to the trailing portion 64 of the second groove is about 50/50.

It is believed that this configuration will provide the tread surface with a more aggressive grip when the tyre is rotated in the second direction (opposite the first direction indicated by the arrow P) than when the tyre is rotated in the first direction indicated by the arrow P. The ratio of the width of the tread surface 38 of the land 39 to the width of one of the grooves 10 is about 60/40.

It will be appreciated that these ratios may be varied slightly as necessary to achieve the desired summer and winter performance for the tyre.

Although Figure 8 shows the configuration of inclined grooves 10, the shoulder grooves 26, 28 may be of similar configuration to provide a grip. Furthermore, where the widths of adjacent shoulder grooves 26, 28 differ and the lands 30, 32 defining those grooves also differ in width, the relative ratios indicated above are maintained so far as possible.

It is important that as well as providing good water expulsion from between the ground-contacting region and the ground in both directions of rotation that when rotating in the second direction, the tread must be self-cleaning to tend to prevent snow accumulations in the cuts and grooves of the tyre.

Arrows, or other appropriate markings are provided on the tyre, conveniently by moulding into a tyre wall, to indicate the correction directions of rotation for summer and winter conditions and appropriate seed index markings.

CLAIMS

1. A tyre for a vehicle wheel, the tyre having a tread portion intended to engage the ground and being so constructed and arranged that when a wheel carrying the tyre is rotated in a first direction it provides a performance suitable for summer conditions and that when a wheel carrying the tyre is rotated in a second direction opposite the first direction it provides a performance suitable for winter conditions.

2. A tyre according to claim 1 which has a tread pattern on the tread portion which, when the tyre is rotated in the first direction, provides a less aggressive grip on the ground surface than when rotated in the second direction.

3. A tyre according to either one of claims 1 and 2 wherein the tread pattern includes a plurality of first inclined grooves inclined at an acute angle to a circumferential line around the tread portion considered from the leading end of the groove to the trailing end of the groove when the tyre is rotated in the first direction and extending from a central region of the tyre towards a shoulder region of the tyre.

4. A tyre according to claim 3 comprising a continuous relatively rigid part or parts of the tread portion or a first continuous groove or grooves extending circumferentially around the tyre at the central region of the tread portion.

5. A tyre for a vehicle wheel wherein the tread portion comprises:

(i) a plurality of first inclined grooves inclined at an acute angle to a circumferential line around the tread portion considered from

the leading end of the groove to the trailing end of the groove when the tyre is rotated in a first direction and extending from a central region of the tyre towards a shoulder region of the tyre; and

(ii) a continuous relatively rigid part or parts of the tread portion, or a first continuous groove or grooves extending circumferentially around the tyre at the central region of the tread portion.

6. A tyre according to either one of claims 4 and 5 comprising two second continuous grooves extending circumferentially around the tread portion one at either side of and spaced from the central region, the second continuous grooves separating the shoulder regions of the tread portion from the remainder of the tread portion.

7. A tyre according to claim 6 wherein the second continuous grooves are each spaced equidistant from the central region and the outer edge of the adjacent shoulder region.

8. A tyre according to any one of claims 3 to 7 wherein the first inclined grooves become progressively wider from the end at the central region towards their outer ends.

9. A tyre according to any one of claims 3 to 8 wherein the first inclined grooves are arranged in pairs, the ends of the grooves of reach pair at the central region lying at a region extending transversely of the tread portion parallel with the axis of rotation of the tyre.

10. A tyre according to claim 9 comprising first shoulder grooves which meet and provide continuations of the first inclined grooves and

which extend across the shoulder region to the outer edge portion of the shoulder region.

11. A tyre according to claim 10 wherein the first shoulder grooves across the shoulder regions extend in a direction generally parallel with the axis of rotation of the tyre.

12. A tyre according to either one of claims 10 and 11 comprising second shoulder grooves positioned between and parallel with the first shoulder grooves, and likewise extending across the shoulder region to the outer edge portion of the shoulder region.

13. A tyre according to claim 12 comprising second continuous grooves separating the shoulder regions from the remainder of the tread portion wherein inner end portions of the second shoulder grooves open from the adjacent second continuous groove.

14. A tyre according to any one of claims 10 to 13 wherein the shoulder grooves are defined by lands of the shoulder region and the shoulder grooves include a recess in a trailing land edge portion which defines the leading edge of a shoulder groove considered when the tyre is rotated in the first direction, the recess being at an outer edge portion of the tread portion.

15. A tyre according to any one of claims 3 to 14 wherein the first inclined grooves are defined by lands of the tread portion at either side of each first inclined groove and wherein the trailing land edge portion defining a leading edge portion of a first inclined groove considered when the tyre is rotated in a first direction, has a series of cuts.

16. A tyre according to claim 15 wherein the cuts are generally parallel to one another.

17. A tyre according to claim 16 wherein the cuts extend in a direction generally parallel to the axis of rotation of the tyre.

18. A tyre according to any one of claims 10 to 14 wherein cuts are provided in a trailing land edge portion which defines the leading edge of a shoulder groove considered when he tyre is rotated in the first direction.

19. A tyre according to claim 18 wherein the shoulder cuts are generally parallel with one another.

20. A tyre according to claim 18 wherein the shoulder cuts are generally parallel with the axis of rotation of the tyre.

21. A tyre according to either one of claims 19 and 20 wherein cuts parallel with the cuts in the land edge portion defining the shoulder grooves are also formed in a land edge portion of the shoulder region defining the second continuous groove.

22. A tyre according to any one of the preceding claims wherein the tread portion comprises a plurality of formations which, when the tyre is rotated in the first direction, are urged towards one another at the region of the tread contacting the ground to present a relatively smooth ground engaging surface and when the tyre is rotated in the second direction, are urged at the ground - contacting region to present a rougher ground contacting portion.

23. A tyre according to any one of claims 3 to 21 wherein the inclined grooves and shoulder grooves are defined by lands at either side of each groove wherein the tread surface of a first land where it meets the leading edge of a groove considered when the tyre is rotated in the first direction subtends an angle with the wall of the groove at its leading edge which is smaller than the angle subtended by the tread surface of a second land defining the trailing edge of the groove and the wall of the groove at its trailing edge.

24. A tyre according to claim 23 wherein the angle subtended at said leading edge of the groove is between 90° and 94° and the angle subtended at said trailing edge is between 96° and 100°.

25. A tyre according to either one of claims 23 and 24 wherein, considered between the centres of adjacent inclined or shoulder grooves of the tread portion at either side of a single land, a first half of the distance between the centres consists of a leading portion of a first groove and a trailing portion of the land and the other half of the distance consists of a leading portion of the land and a trailing portion of a second groove and wherein the ratio of the circumferential width of said trailing portion of the land to said leading portion of the first groove is greater than the ratio of the width of said leading portion of the land to the trailing portion of the second groove.

26. A tyre according to any one of the preceding claims wherein the tread portion is made from a compound which provides a satisfactory performance over a wide range of temperature conditions.

27. A tyre according to any one of the preceding claims wherein the tread portion is made from a compound which, when the tyre is rotated in the first direction, provides a performance when engaging the ground appropriate to high temperature summer conditions and when rotated in the second direction provides a performance appropriate to relatively low temperature winter conditions.

28. A tyre according to any one of claims 1 to 27 wherein the tyre tread compound has a hardness at -5°C ambient air temperature in the range 58-66 on the Shore A scale.

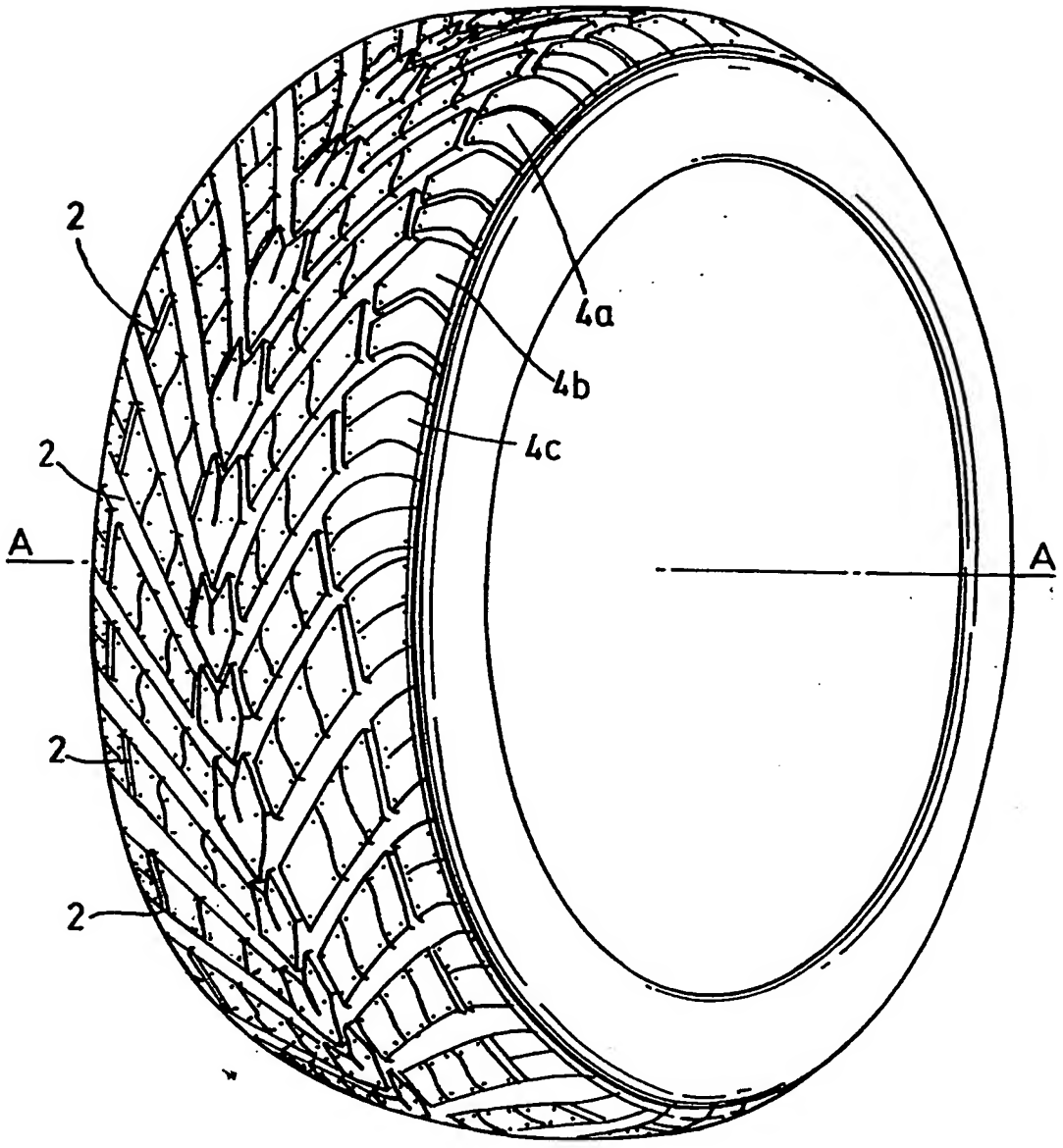

Fig. 1

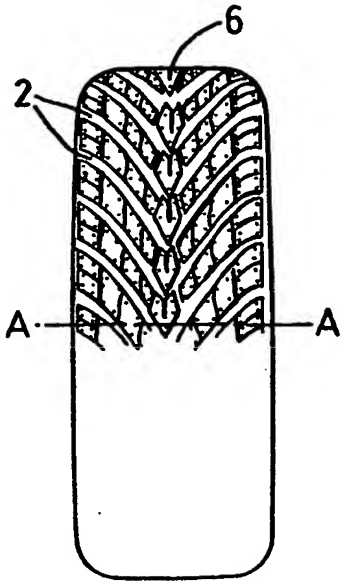

Fig. 2

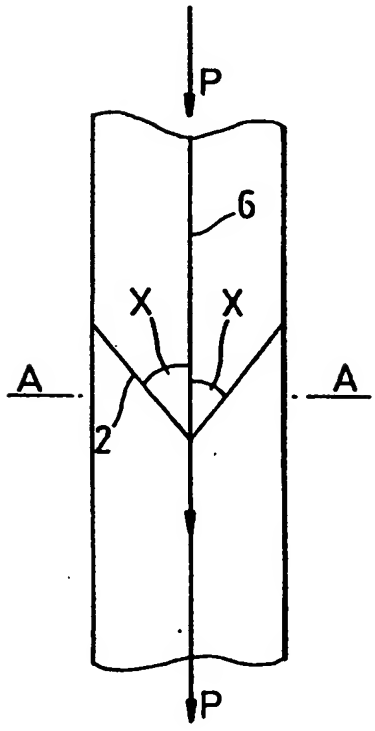

Fig. 3

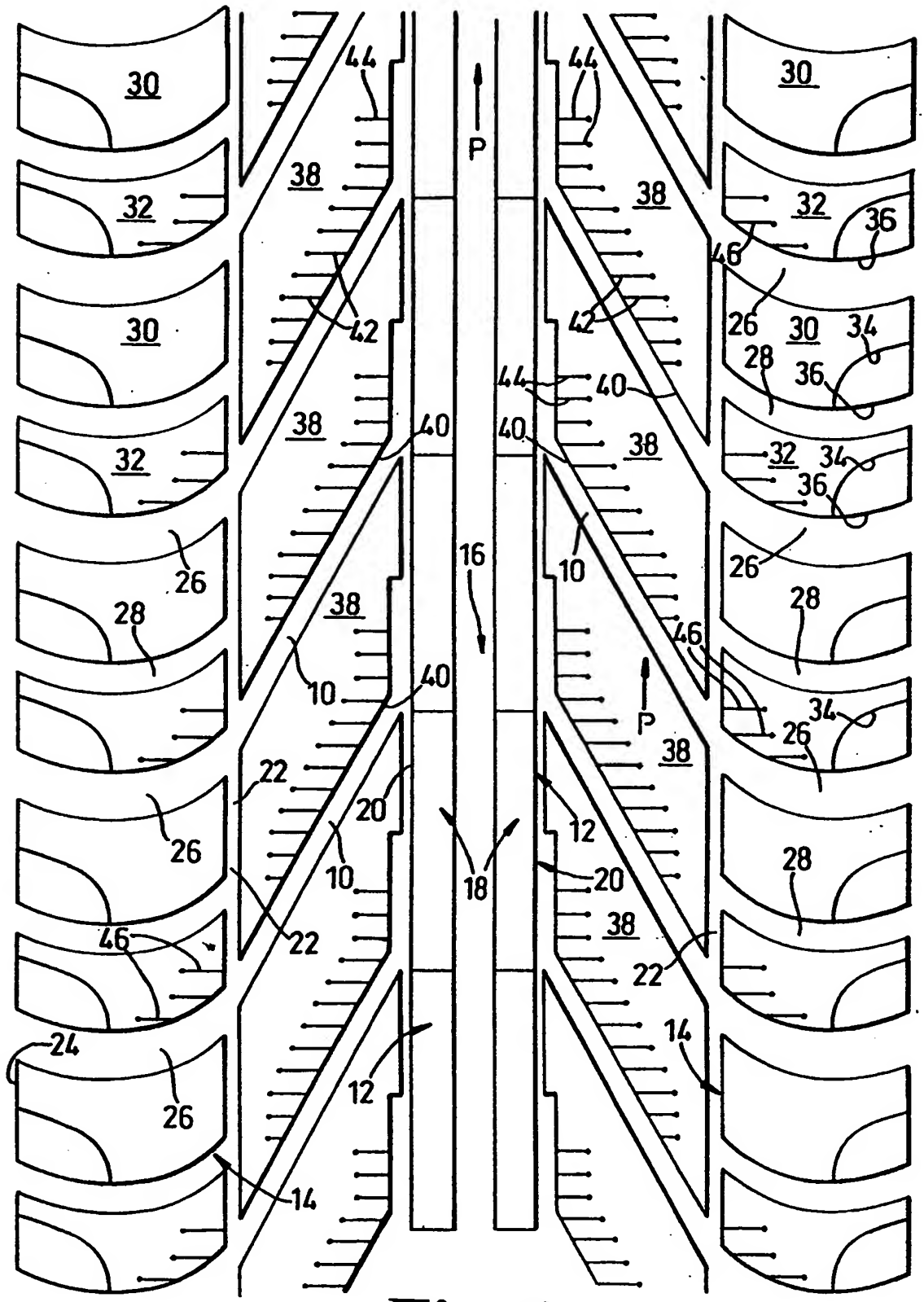
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Fig. 4

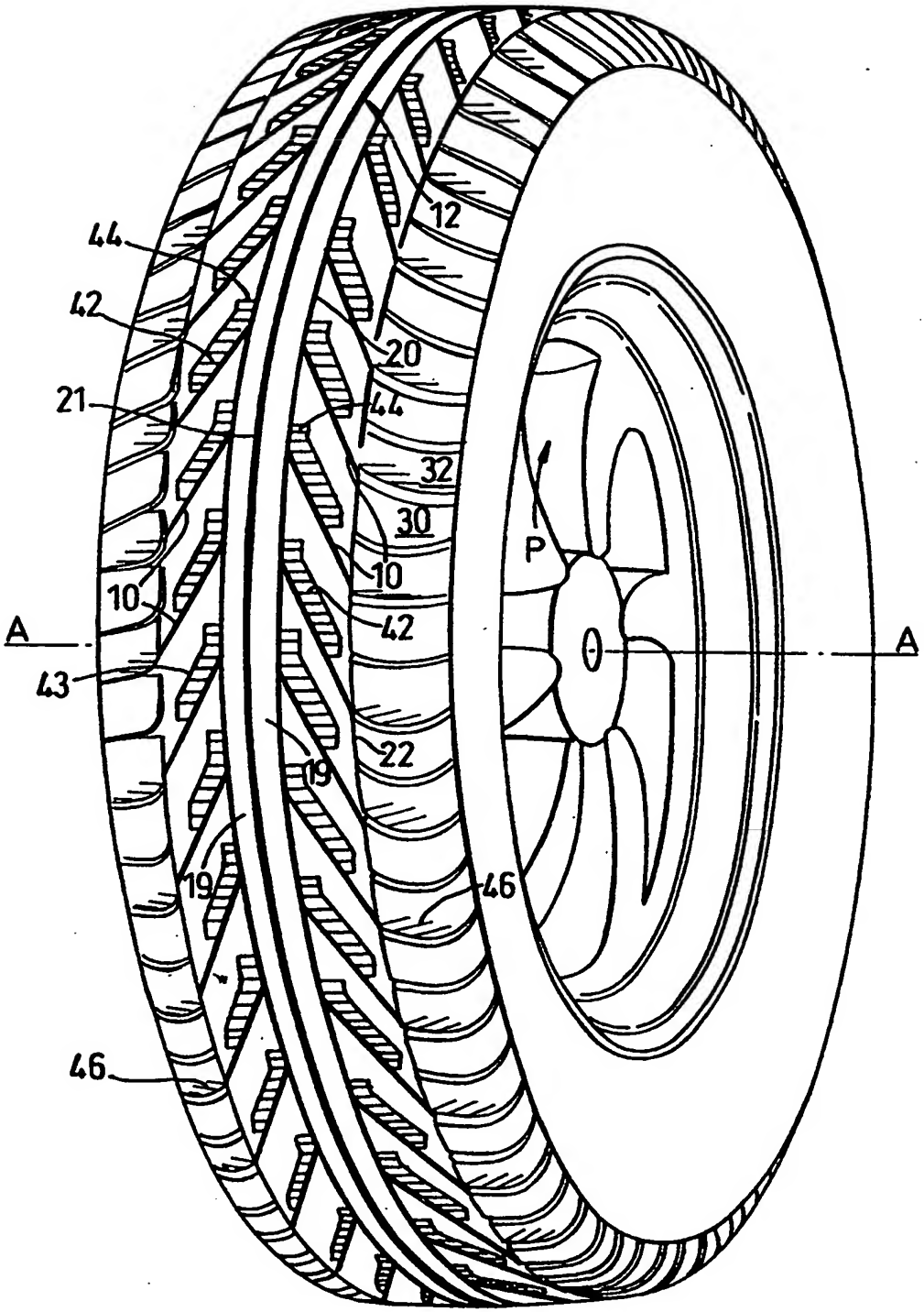

Fig. 5

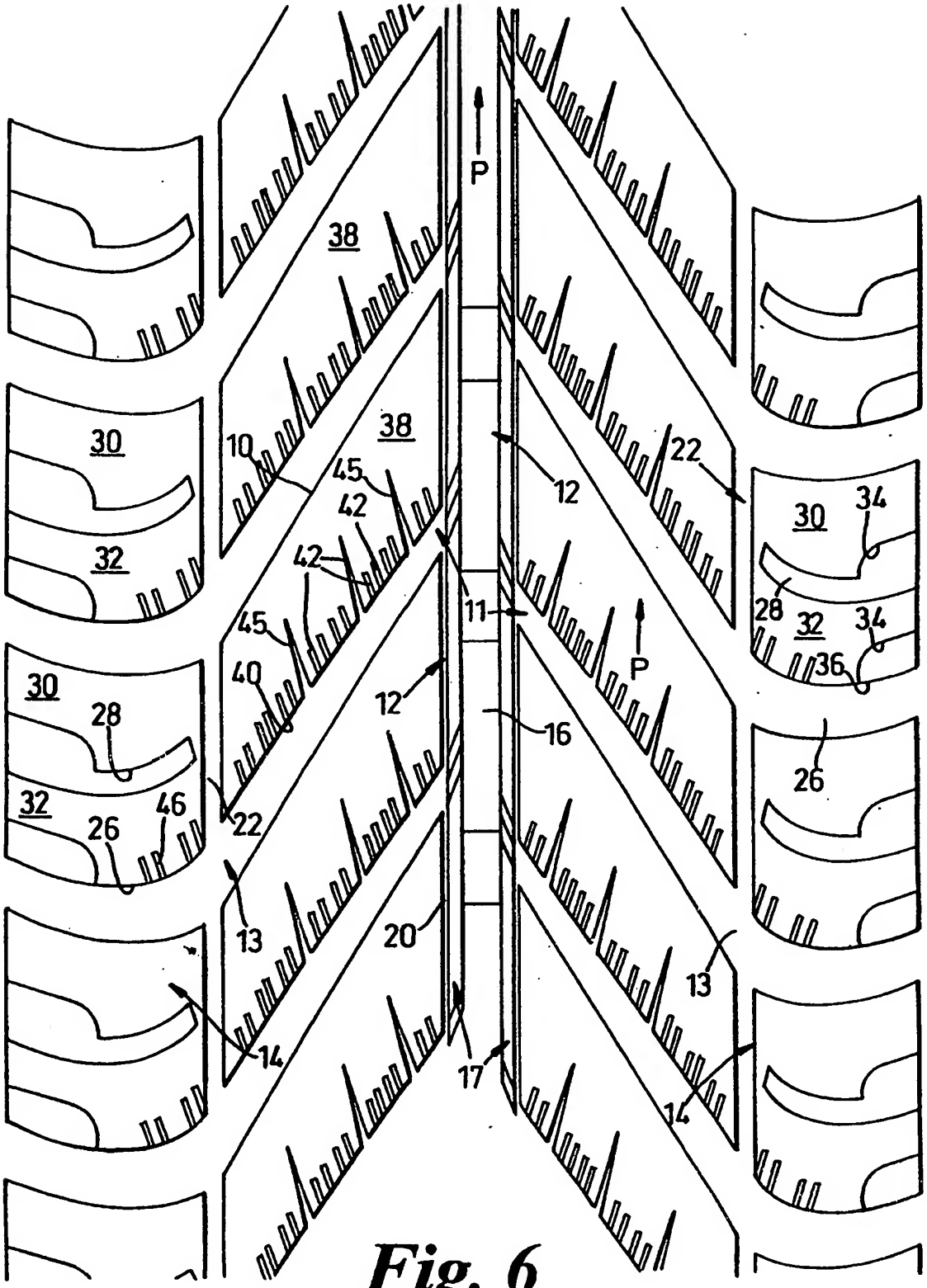
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Fig. 6

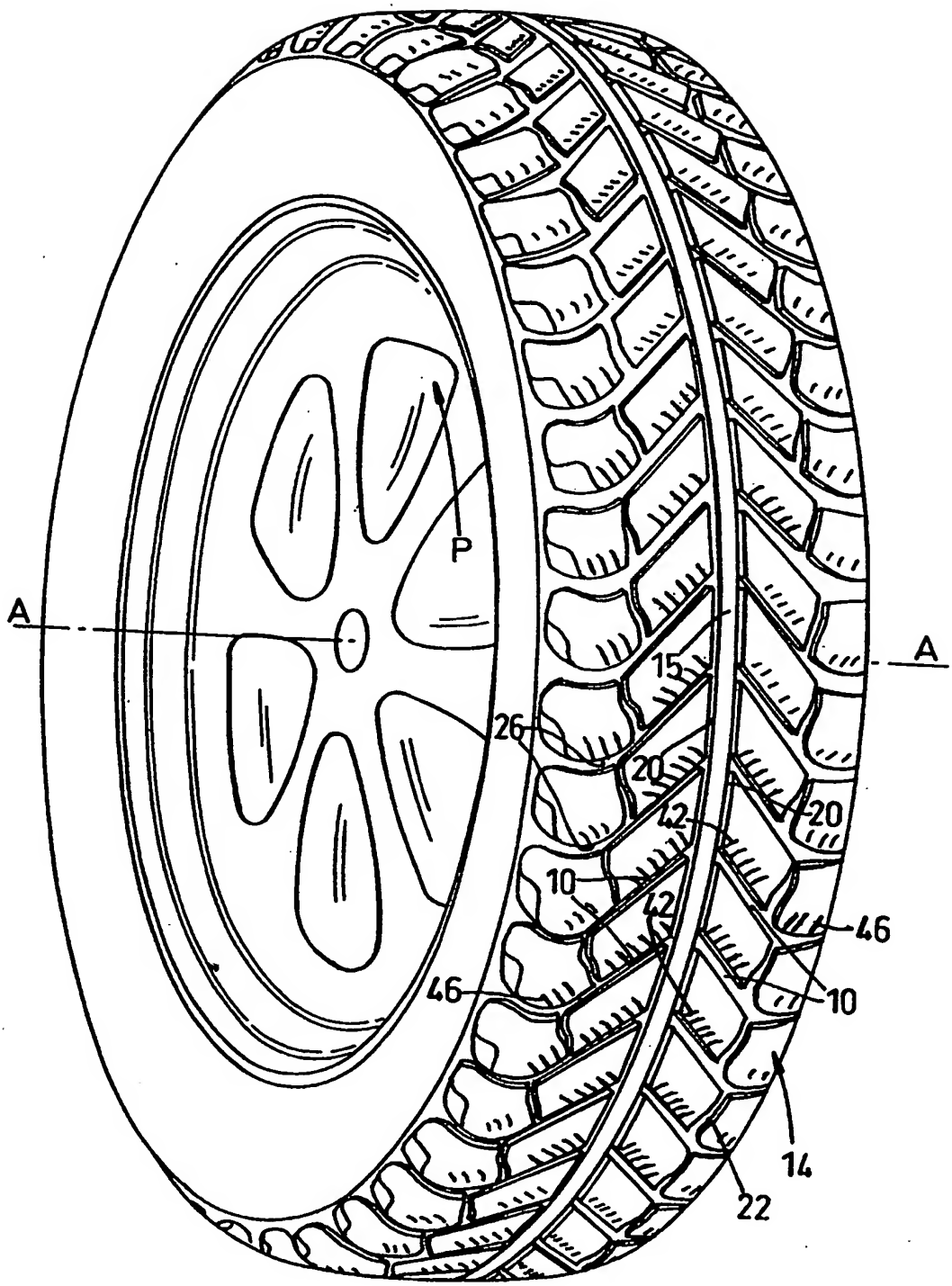

Fig. 7

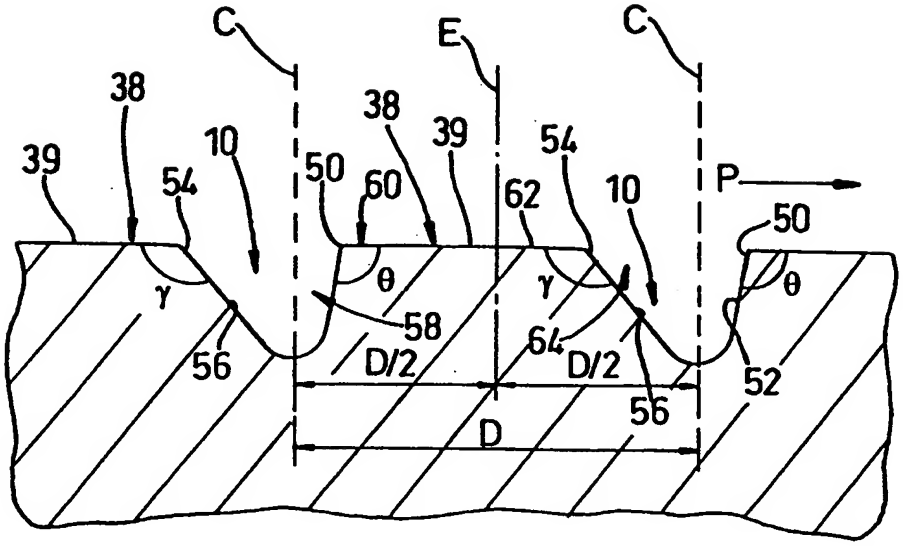

Fig. 8

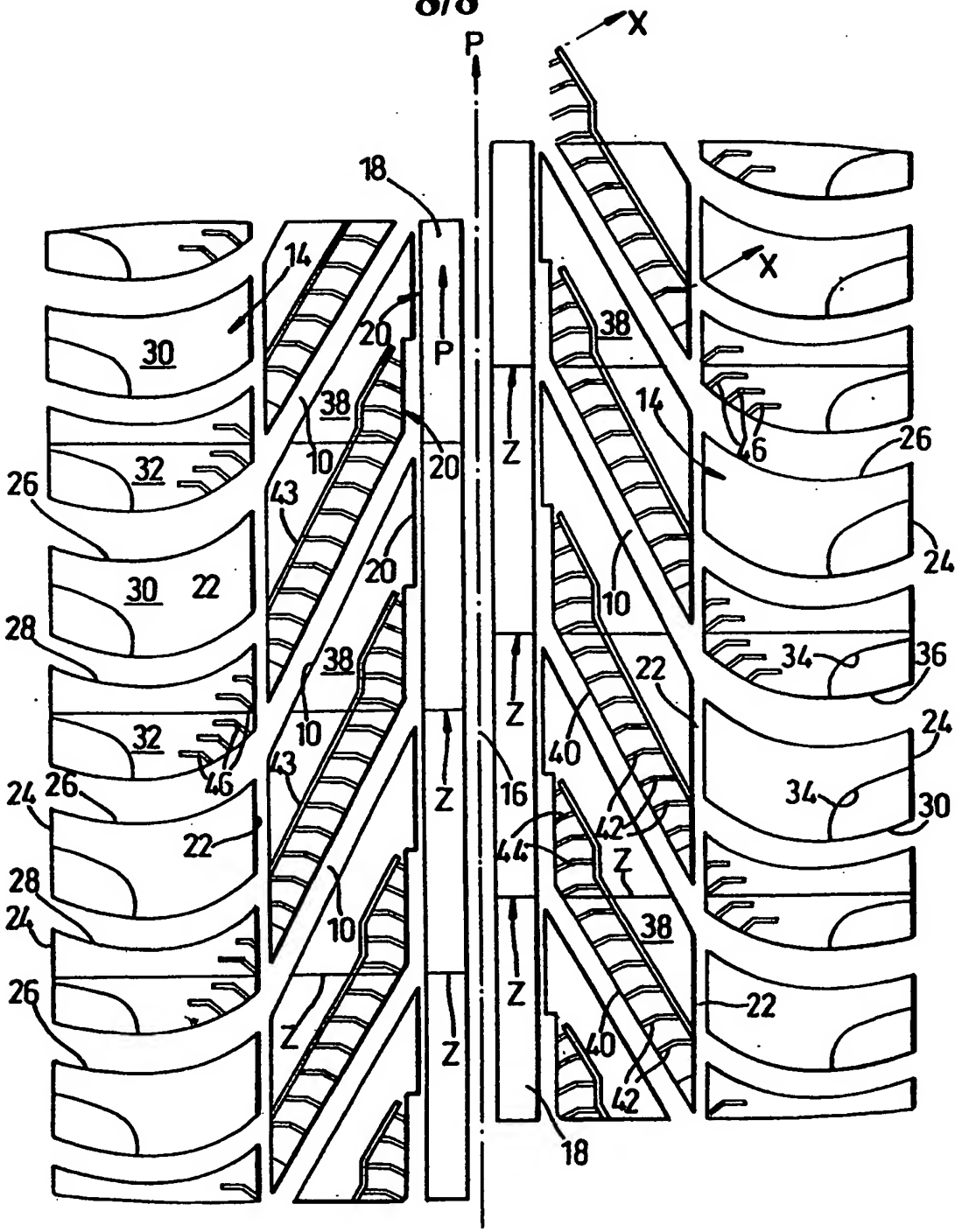

Fig. 9

Fig. 10

INTERNATIONAL SEARCH REPORT

Int. ional Application No
PCT/GB 98/02972

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60C11/03 B60C11/00 B60C11/13

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 43 19 713 A (BRANNAN DAVID) 22 December 1994 see the whole document	1-5
X	EP 0 688 685 A (BRIDGESTONE CORP) 27 December 1995 see page 6, line 4 - line 26; claims; figures; example 2	5,23-25
X	EP 0 172 974 A (GOODYEAR TIRE & RUBBER) 5 March 1986 see page 1, line 23 - page 2, line 21 see page 8, line 11 - line 15	1,5,8
X	DE 42 32 308 A (CONTINENTAL AG) 31 March 1994 see column 4, line 66 - column 5, line 23; claims; figures 4-6	5,15-22

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December 1998	22/12/1998

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Int. Jonal Application No
PCT/GB 98/02972

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 296 605 A (UNIROYAL ENGLEBERT GMBH) 28 December 1988 see column 5, line 51 - column 6, line 48; claims; figures	5-11
X	US 4 700 762 A (LANDERS SAMUEL P) 20 October 1987 see claims; figures	5-11
X	EP 0 565 270 A (BRIDGESTONE CORP) 13 October 1993 see claims; figures	5-13
X	EP 0 503 405 A (GOODYEAR TIRE & RUBBER) 16 September 1992 see claim 1; figures 4,4A	5-7, 23-25
A	EP 0 761 734 A (SEMPERIT AG) 12 March 1997 see tables	26-28
A	EP 0 548 040 A (SEMPERIT AG) 23 June 1993 see page 2, line 23 - line 27	26-28

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte ional Application No
PCT/GB 98/02972

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4319713 A	22-12-1994	NONE	
EP 0688685 A	27-12-1995	JP 8002216 A	09-01-1996
		JP 8002217 A	09-01-1996
		JP 8020206 A	23-01-1996
		JP 8113015 A	07-05-1996
		JP 8142613 A	04-06-1996
EP 0172974 A	05-03-1986	AU 546979 A	24-10-1985
		DE 8524632 U	31-10-1985
		FR 2569622 A	07-03-1986
		US 4667717 A	26-05-1987
DE 4232308 A	31-03-1994	NONE	
EP 0296605 A	28-12-1988	DE 3720854 A	05-01-1989
		DE 3723368 A	30-03-1989
		DE 3868713 A	09-04-1992
US 4700762 A	20-10-1987	NONE	
EP 0565270 A	13-10-1993	JP 5286312 A	02-11-1993
		DE 69318615 D	25-06-1998
		DE 69318615 T	19-11-1998
		ES 2116408 T	16-07-1998
		US 5423364 A	13-06-1995
EP 0503405 A	16-09-1992	AU 646927 B	10-03-1994
		AU 1212392 A	10-09-1992
		CA 2054991 A	09-09-1992
		JP 5092704 A	16-04-1993
		MX 9200891 A	01-09-1992
		TR 25971 A	01-11-1993
		US 5358022 A	25-10-1994
		US 5327952 A	12-07-1994
EP 0761734 A	12-03-1997	AT 148295 A	15-11-1998
		CA 2184932 A	08-03-1997
		CN 1151999 A	18-06-1997
		CZ 9602636 A	18-02-1998
		JP 9118786 A	06-05-1997
		US 5717022 A	10-02-1998
EP 0548040 A	23-06-1993	AT 401775 B	25-11-1996
		AT 250691 A	15-04-1996